Returning Shuttle to Safe Flight

Bryan O'Connor, NASA Headquarters
Associate Administrator for
Safety and Mission Assurance

Presentation to the Safety and Health Managers Meeting

March 3, 2004

Overview

- *Columbia* Accident Scenario and Board Recommendations
- Return to Flight (RTF) Process
- NASA Plan and Technical Challenges for RTF
- The Risk Outlook

Columbia Accident Scenario

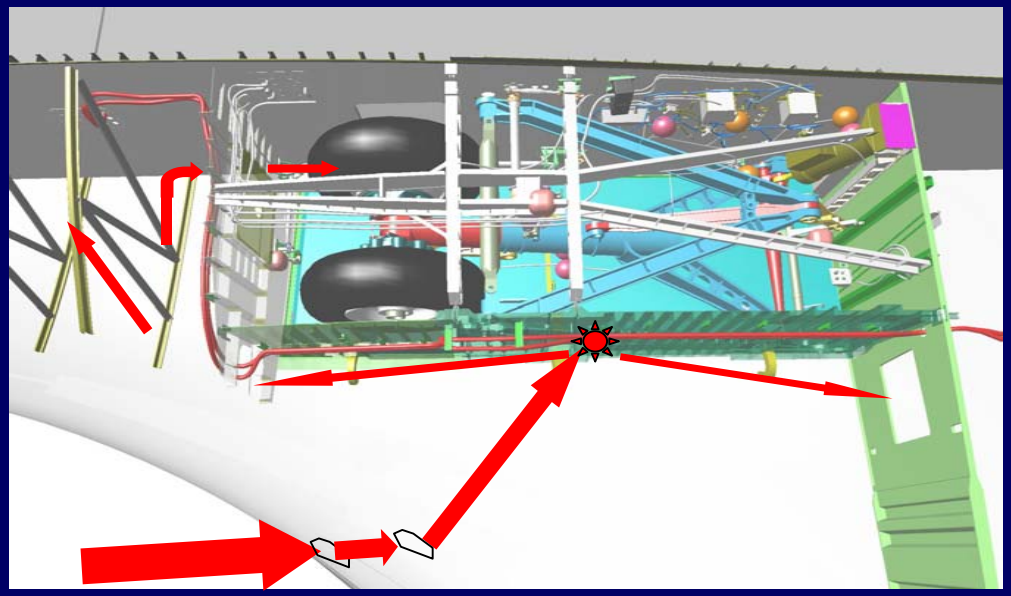
- 81 seconds after launch, at an altitude of 65,000 feet, Mach 2.46, bipod foam separates from the ET

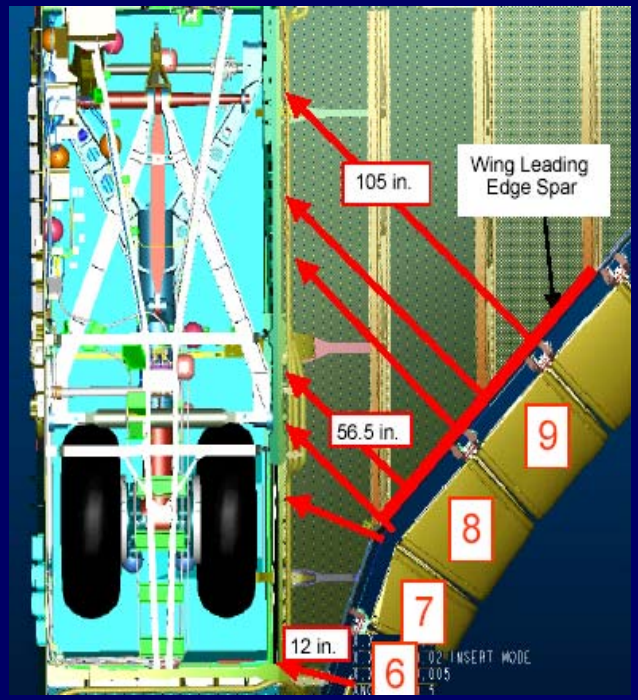
- Foam, 21 to 27 inches long by 12 to 18 inches wide, weighing 1.67 pounds strikes the vehicle at relative velocity of ~545mph

- Foam impacts Wing Leading Edge Reinforced Carbon-Carbon near Panels 8-9

Columbia Accident Scenario

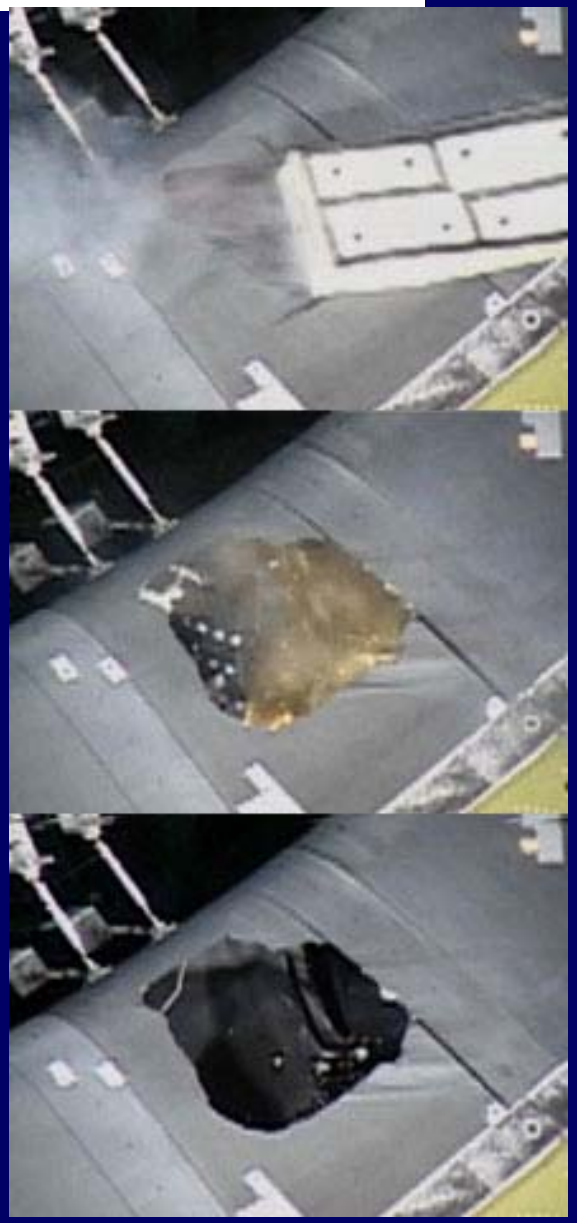
- On re-entry, plasma enters the breached leading edge of the wing near Reinforced Carbon-Carbon Panels 8-9
- Plasma flow in left wing degrades internal structural integrity
- Vehicle motion too great for flight control system to manage, leads to loss of vehicle control and aerodynamic break-up





Impact Test Confirms Accident Scenario

- Several million CFD runs on high speed computers at Ames have verified speed of liberated foam (>700 ft/sec)
- Investigators conducted 6 full scale tests with little or no damage, then on the 7th try, they found the “smoking gun”
- Reinforced Carbon-Carbon Panel # 8 impacted with a 1.67 pound piece of foam moving at a speed of 777 ft/sec
- Impact leaves 16-17 inch diameter hole
- Tests confirm accident scenario



Organizational Cause Factors

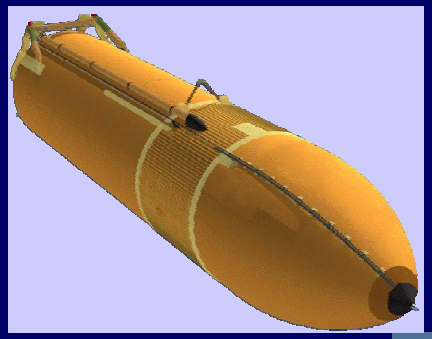
"Cultural traits and organizational practices detrimental to safety":

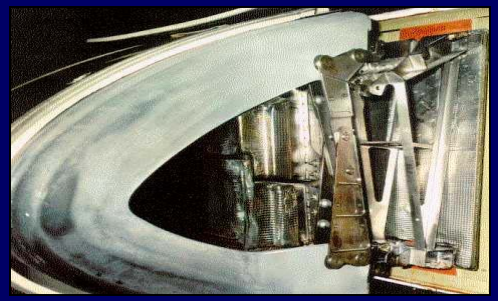
- *reliance on past success*
- *organizational barriers to effective communications*
- *lack of integrated management*
- *informal decision-making processes*

Columbia Board Recommendations

29 Recommendations in the Following Categories:

- Improve Thermal Protection System Monitoring and Repair
- Fix Debris Shedding from the External Tank
- Improve Vehicle Imaging Capability
- Qualify the Bolt Catcher Separation Mechanism
- Improve Flight Hardware Closeout Documentation
- Improve the Foreign Object Debris Program
- Improve MMT Training
- Launch Schedules Consistent with Resources
- Upgrade Orbiter Sensor Data
- Create an Independent Technical Engineering Authority
- Upgrade Closeout Photo Process
- OSMA take direct line authority over all SMA
- Re-Certify the Shuttle for Flights beyond 2010





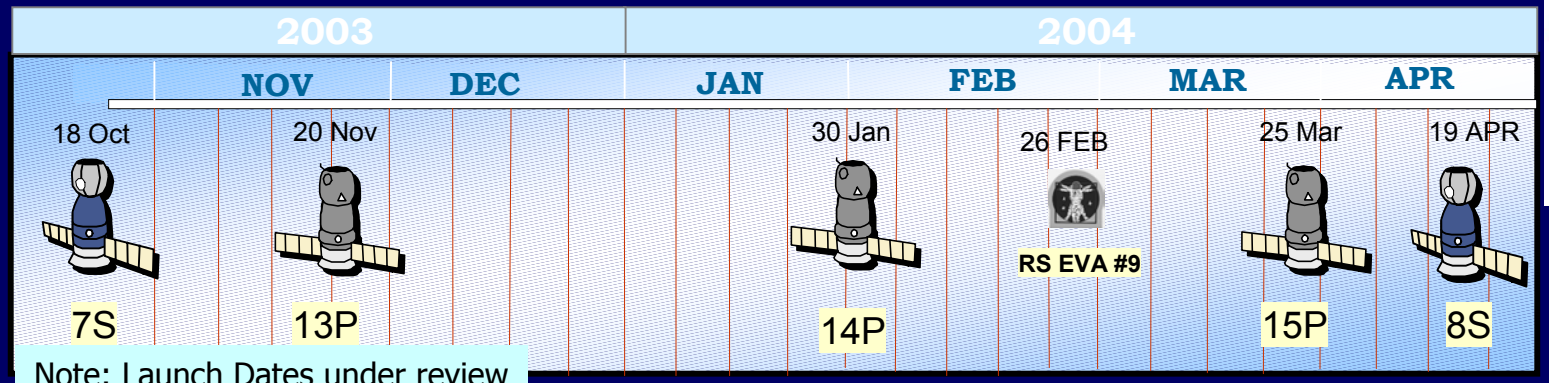
ISS On-Orbit Operating Status

- Reduced Crew in good shape
- Critical consumables currently on board maintainable thru Spring 04
- Water conservation working well
- On-orbit subsystems performing well
- Relieves Progress resupply pressure

Expedition 8
Oct 2003 – April 2003

Alexander Kaleri
Flight Engineer

C. Michael Foale
Commander

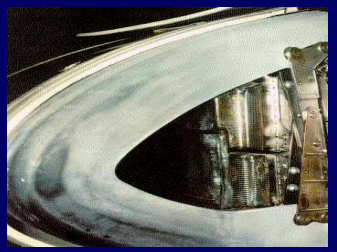


Note: Launch Dates under review

Return to Flight Critical Activities

Orbiter
- RCC Inspection/Installation
- Tile Inspections
- Other Non-Columbia issues (Rudder Speedbrake)

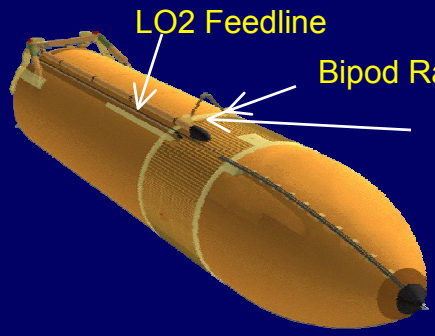
Tile Bonding



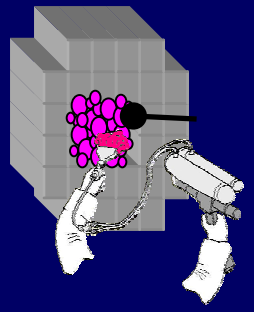
Wing RCC Panel

External Tank Certification
- Bipod Foam Ramp Redesign
- Feedline Bellows Redesign
- Intertank Flange Debris Prevention

Bipod Foam Ramp

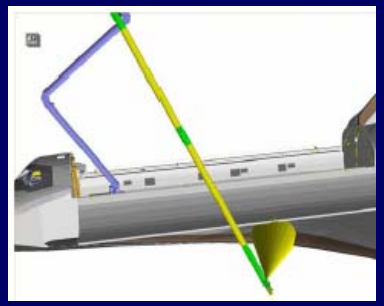


Risk Mitigation
- Tile and RCC Repair
- Boom and Sensor Installation
- Improve Camera Coverage
- Safe Haven on ISS



Tile Repair Concept

On-orbit Boom inspection



RTF Task Group – Stafford-Covey Task Group

Lt. Gen. Thomas Stafford
Former Apollo Astronaut

Mr. Richard O. Covey
Former Shuttle Astronaut

Purpose and Objective: Perform an independent assessment of NASA's actions to implement the recommendations of the CAIB, as they relate to the safety and operational readiness of STS-114.

Co-Chairmen
Lt. Gen. Stafford and Mr. Covey

Astronaut Rep
Lt. Col. Carlos Noreiga

Executive Secretary
Mr. David Lengyel

Management Panel
Dr. Dan Crippen
Col. Gary Geyer

- Dr. Walter Broadnax
- Hon. Richard Danzig
- Gen. Ron Fogleman
- Ms. Susan Livingstone
- Mr. Tom Tate
- Mr. Bill Wegner

Technical Panel
Mr. Joe Cuzzupoli

- RADM Walt Cantrell
- Dr. Kathryn Clark
- Mr. Ben Cosgrove
- Dr. Chuck Daniel
- Mr. Dick Kohrs
- Dr. Decatur Rogers
- Mr. Sy Rubenstein

Operations Panel
Col. Jim Adamson

- Maj. Gen. Bill Anders
- Dr. Amy Donahue
- Lt. Gen. Forrest McCartney
- Dr. Rosemary O'Leary
- Mr. Bob Sieck
- Dr. Kathryn Thornton
- Ms. Susan Helms
- Ms. Christine Fox

Mr. James Lloyd
Safety & Mission Assurance
Ex-Officio Member

ISS Assembly Challenges Ahead

Following Shuttle RTF:

- 8 missions to reach U.S. Core complete
- ~19 additional missions to reach International Partner Core complete

- ~6-7 years to International Partner Core complete
- Human Shuttle missions to ISS terminated after IP Core Complete

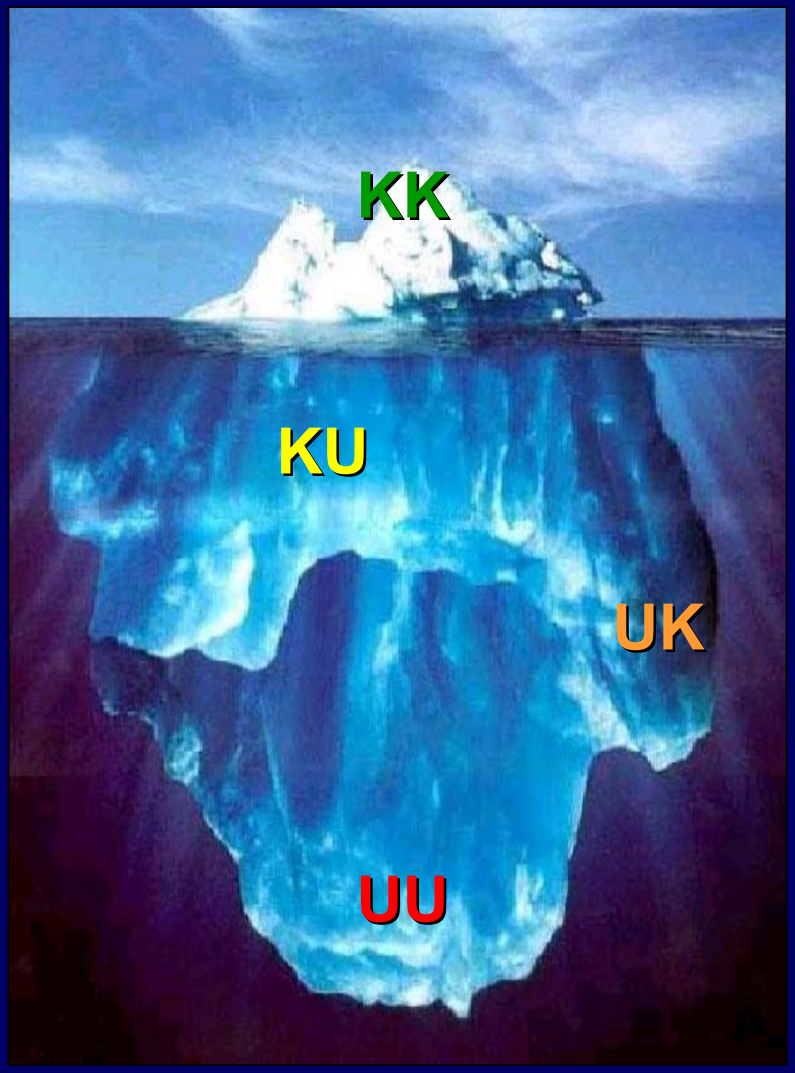
Launch Planning – RTF Schedule

RTF Launch Window

- Milestone driven
- Milestones established by technical improvements
- Launch constraints will limit flight opportunities
- Earliest Planning Date Mar ’05 (protects May safe haven/rescue)

RTF from the Risk Perspective

- **Known Knowns**
  - Data based knowledge
  - Demonstrated performance
  - Test-validated analysis, models
  - Operation within certification
- **Known Unknowns**
  - Generic but undemonstrated hazards
  - Risk analysis uncertainties
  - Acknowledged test and analysis limitations
  - Modeling and simulation based predictions
  - Operation within cert but out of family
- **Unknown Knowns**
  - Miscommunicated test or analysis results
  - Poor understanding of data or environment
  - Poor documentation & loss of corp. memory
- **Unknown Unknowns**
  - Wrong assumptions
  - Untested environments
  - True experimental research
  - Operation outside of certification



Addressing the Risks

- **If the NASA mission is about defying gravity,**

then

- ***The Shuttle RTF strategy is about defying buoyancy***

  - ***Known Unknowns: (Hazard Analysis and Risk Management)***
    - *Reduce uncertainties with testing, analysis and attention to flight performance*
    - *Recertify to the real environment*
    - *Treat remaining uncertainty with conservative ground and flight procedures and operating margins (hazard controls)*
  - ***Unknown Knowns: (Continuous Process Improvement)***
    - *Continuously assess and improve program communications, documentation, workforce competence*
    - *Go to root cause on mishap investigations*
    - *Improve data analysis tools and techniques (e.g. trending, mining, etc.)*
  - ***Unknown Unknowns: (Research, Test and Evaluation)***
    - *Understand the limitations of the system in the real environment;*
    - *Challenge our old assumptions, models and analyses*

Summary

- NASA embraces the Columbia Board Report
- NASA will “Raise The Bar” to ensure a safe mission return to flight
- RTF process is deliberate, cautious, risk informed and milestone driven
- Three Orbiter Shuttle fleet supports continued ISS assembly and operation
- Safe return to flight is the first goal of the President’s new exploration vision